CLAIMS

We claim:

1.   In an OFDM receiver to wirelessly receive a packet of information that includes a known transmitted part, the receiver including a signal-to-tone transformer to determine the subcarriers of a signal corresponding to a received packet, an apparatus comprising:

a channel storage unit coupled to the signal-to-tone transformer including:

an initial channel calculator to calculate a function of the initial channel response of subcarriers from the known part of the received packet;

a memory subsystem coupled to the initial channel calculator initially to store the function of the initial channel response, and then to store updates of the function of the initial channel response;

a channel corrector coupled to the channel storage unit and to the signal-to-tone transformer to correct the modulated subcarriers of the received signal for the respective channel using the contents of the memory subsystem; the channel corrector to form channel corrected constellation values for the received signal;

a decision and channel drift circuit coupled to the channel corrector to form post-decision values corresponding to the channel corrected constellation values and to form a measure of the channel drift from the post decision constellation values and the pre-decision constellation values; and

a weighting and summing circuit coupled to the channel storage unit to update the memory subsystem with a weighted sum of the pre-update contents of the memory subsystem and an update, the update determined from the memory subsystem contents and the measure of the channel drift between symbols,

such that the memory subsystem contents track channel drift from symbol to symbol, the tracking according to the relative weightings of the weighted sum.

2.   An apparatus as recited in claim 1, wherein the function of the channel response stored in the memory subsystem for a subcarrier is the channel response for the subcarrier multiplied by the known value of the subcarrier for the known part, such that a factoring of the known part is included prior to or concurrent with channel correcting.

3.   An apparatus as recited in claim 1, wherein the function of the channel response stored in the memory subsystem for a subcarrier is post factoring by the known value of the subcarrier for the known part, such that a factoring of the known part is included prior to the input from the signal-to-tone transformer to the memory subsystem.

4.   An apparatus as recited in claim 1, wherein the signal-to-tone transformer produces subcarriers in rectangular coordinates, and wherein the memory subsystem stores the function of the channel response in rectangular coordinates.

5.   An apparatus as recited in claim 1, wherein the signal-to-tone transformer produces subcarriers in rectangular coordinates, and wherein the memory subsystem stores the function of the channel response in polar coordinates.

6.   An apparatus as recited in claim 1, wherein the decision circuit forms a hard decision.

7.   An apparatus as recited in claim 1, wherein the decision circuit produces re-encoded decoded decisions.

8.   An apparatus as recited in claim 1, wherein the subcarriers of the packet include pilot tones, the apparatus further comprising a pilot correction circuit between the channel corrector and the decision circuit, the pilot correction circuit to correct for one or both of channel drift and timing errors, such that the channel corrector need not account for the carrier drift and the timing errors in correcting for the channel.

9.   An apparatus as recited in claim 1, wherein the receiver includes a circuit to measure the signal quality, and wherein the relative weightings of the weighted sum is a function of the measured signal quality.

10. An apparatus as recited in claim 9, wherein the receiver is to receive a packet that includes a field modulated at a known rate, and wherein the circuit to measure the signal quality provides a measure of the signal quality of the received field.

11. An apparatus as recited in claim 10, wherein the memory is updated only in the case that the measure of signal quality of the received signal field is above a signal quality threshold.

12. An apparatus as recited in claim 10, wherein the circuit to measure the signal quality provides a measure of the EVM of the received signal field.

13. An apparatus as recited in claim 12, wherein the memory is updated only in the case that the measure of EVM of the received signal field is above a settable EVM threshold.

14. An apparatus as recited in claim 1, wherein the decision circuit operates in rectangular coordinates.

15. An apparatus as recited in claim 1, wherein the decision circuit operates in polar coordinates.

16. An apparatus as recited in claim 1, wherein the channel drift circuit inverse modulates the decision made for each constellation point and multiplies the pre-decision constellation value with the inverse re-modulated decision value to form a signal that varies as the measure of the channel drift.

17. An apparatus as recited in claim 1, wherein the known part of the packet includes a first part of at least one known symbol and a second part of at least one known symbol, and wherein the initial channel calculator initially stores a function of the channel response based on received signals corresponding to the first part, and wherein initial channel calculator and memory are arranged to average the functions of the channel responses corresponding to the first and second parts, such that after the signals corresponding to the second known part are received, the function of the initial channel response in the memory is the average of the functions of the channel responses corresponding to the first and second parts.

18.   An apparatus as recited in claim 17, wherein the signal-to-tone transformer produces subcarriers in rectangular coordinates, and wherein the channel correcting is in polar coordinates, the apparatus further comprising a rectangular to polar coordinate transformer between the signal-to-tone transformer and the channel corrector.

19.   An apparatus as recited in claim 17, wherein the first and second part each include a known symbol, and wherein the function of the channel response for a subcarrier is the channel response for the subcarrier multiplied by the known value of the subcarrier of the known symbol, such that a factoring by the known part is included prior to or concurrent with channel correcting, and such that the function of the initial channel response initially in the memory is the average of the channel responses multiplied by the subcarriers corresponding to the known symbol sets.

20.   An apparatus as recited in claim 17, wherein the function of the channel response stored in the memory subsystem for a subcarrier is post factoring by the known value of the subcarrier for the known symbol, the apparatus further comprising a factoring unit between the signal-to-tone transformer and the memory subsystem to factor by the known subcarrier value.

21.   An apparatus as recited in claim 17, further comprising a channel drift change detector coupled to the channel drift circuit to detect the change in channel drift, such that the relative weighting is a function of the detected change in channel drift.

22.   An apparatus as recited in claim 21, wherein the memory is updated only if the detected change in channel drift exceeds a change threshold.

23.   An apparatus as recited in claim 21, wherein the change detector includes a loop filter.

24.   An apparatus as recited in claim 20, further comprising a channel smoother coupled to the memory to smooth the channel responses to take into account correlation between channel responses of adjacent subcarriers, the apparatus further including a factoring circuit to factor out the known subcarriers values of the known part.

25.   An apparatus as recited in claim 24, wherein the signal-to-tone transformer produces subcarriers in rectangular coordinates, and wherein the channel correcting is in polar

coordinates, the apparatus further comprising a rectangular to polar coordinate transformer between the signal-to-tone transformer and the channel corrector.

26.   An apparatus as recited in claim 25, wherein the smoothing is in polar coordinates.

27.   An apparatus as recited in claim 24, wherein the channel smoother is adaptive such that the amount of smoothing of the channel smoother is selected from a set of candidate smoothers according to how well the channel estimates produced by applying each candidate smoother to channel estimates produced from the first part predict the received signal corresponding to the second part.

28.   In an OFDM receiver to wirelessly receive a packet of information that includes a known transmitted part, the receiver including a signal-to-tone transformer to determine the subcarriers of a signal corresponding to a received packet, a method comprising:

accepting the subcarriers of the known part of the received packet;

calculating a function of the initial channel response of subcarriers from the known part of the received packet;

storing the function of the initial channel response;

storing updates of the function of the channel response as more data is accepted;

channel correcting the modulated subcarriers of the received signal for the channel using the stored initial or updated function of the channel response to form channel-corrected constellation values for the received signal;

forming post-decision values corresponding to the channel corrected constellation values;

forming a measure of the channel drift from the post decision values and the channel-corrected constellation values;

forming a weighted sum of the pre-update stored function of the channel response and an update, the update determined from the pre-update stored function of the channel response and the measure of the channel drift between symbols; and

storing the weighted sum as the updated stored function of the channel response,

such that the stored function of the channel response track channel drift from symbol to symbol, the tracking according to the relative weightings of the weighted sum.

29. A method as recited in claim 28, wherein the storing of the function of the initial channel response for a subcarrier stores the initial channel response for the subcarrier multiplied by the known value of the subcarrier for the known part, the method further comprising:

> factoring out of the known part from the stored function of the channel response prior to or concurrent with channel correcting.

30. A method as recited in claim 28, wherein the storing of the function of the channel response for a subcarrier stores the initial channel response, the method further comprising:

> factoring out of the subcarriers of the known part from the accepted subcarriers corresponding to the known part.

31. A method as recited in claim 28, wherein the storing stores the function of the initial channel response in rectangular coordinates.

32. A method as recited in claim 28, wherein the storing stores the function of the initial channel response in polar coordinates.

33. A method as recited in claim 28, wherein said forming the decision forms a hard demodulated decision.

34. A method as recited in claim 28, wherein said forming the decision produces re-encoded decoded decisions.

35. A method as recited in claim 28, wherein the subcarriers of the packet include pilot tones, the method further comprising:

> pilot correcting the channel corrected constellation to correct for one or both of channel drift and timing errors to form pilot corrected constellation values,

wherein forming the decision uses the pilot corrected values,

such that the channel correcting need not account for the carrier drift and the timing errors in correcting for the channel.

36.   A method of updating channel estimates for a set of subcarriers in an OFDM wireless receiver, the method comprising, for each subcarrier in the set of subcarriers:

storing a function of a first estimate of the channel response for the subcarrier;

accepting a pre-decision constellation point value for the subcarrier, said pre-decision constellation point value being corrected using the first estimate of the channel response;

making a decision using the pre-decision constellation point value;

re-modulating the decision to form a post-decision constellation point value;

forming a complex valued product of the function of the first estimate for the subcarrier and the complex-valued ratio of the pre-decision and post-decision values; and

updating the stored function of the first estimate of the channel response with a weighted amount of the formed complex valued product.

37.   A method as recited in claim 36, wherein the OFDM receiver is to receive a packet that includes a known part having subcarriers with known values, and wherein the storing of a first function stores the channel response for the subcarrier multiplied by the known value of the subcarrier for the known part.

38.   A method as recited in claim 36, wherein the OFDM receiver is to receive a packet that includes a known part having subcarriers with known values, and wherein the storing of a first function stores the first estimate of the channel response of the subcarrier post factoring by the known value of the subcarrier for the known part.

39.   A method as recited in claim 36, wherein the weighted amount is a weighted average of the first estimate and the formed complex valued product.

40.   A method as recited in claim 39, further comprising updating the quantity stored for the subcarrier as more data is received by the receiver.

41.   A method as recited in claim 36, wherein making the decision forms a hard demodulated decision.

42.   A method as recited in claim 36, wherein the received data is encoded, and wherein making the decision includes demodulating, decoding, and re-coding to form a re-coded-decoded decision.

43.   An apparatus to update channel estimates for a set of subcarriers in an OFDM wireless receiver, the receiver able to receive a packet that includes a known part having known values of subcarriers, and a modulated part, the apparatus comprising:

> a memory to initially store a function of a first estimate of the channel response for each subcarrier in the set of subcarriers;

> a decision circuit to accept a pre-decision constellation point value for a received packet for a subcarrier of the set, said pre-decision constellation point value being corrected using the first estimate of the channel response;

> re-modulator coupled to the decision circuit to form a post-decision constellation point value;

> a channel drift circuit to form the complex-valued ratio of the pre-decision and post-decision values;

> a first multiplier to form a complex valued product of the function of the first estimate for the subcarrier and the complex-valued ratio of the pre-decision and post-decision values; and

> a weighting circuit whose output is coupled to the input of the memory, the weighting circuit to form an update for the memory,

> such that the stored function of the first estimate of the channel response is updated with a weighted amount of the formed complex valued product.

44.   An apparatus as recited in claim 43, wherein the memory initially stores the channel response for the subcarrier multiplied by the known value of the subcarrier for the known part.

45. An apparatus as recited in claim 43, wherein the memory initially stores the first estimate of the channel response, the subcarrier post factoring by the known value of the subcarrier for the known part.

46. An apparatus as recited in claim 43, wherein the weighting circuit forms a weighted average of the memory contents and the formed complex valued product.

47. An apparatus as recited in claim 46, wherein the memory contents update as more data is received by the receiver.

48. An apparatus as recited in claim 43, wherein the decision circuit forms a hard demodulated decision.

49. An apparatus as recited in claim 43, wherein the decision circuit and re-modulator are included in one circuit.

50. An apparatus as recited in claim 43, wherein the re-modulator inverse re-modulates, and wherein the channel drift circuit includes a second complex multiplier to multiply the post-decision inverse re-modulated value with the pre-decision value, such that no complex divider is required.

51. An apparatus as recited in claim 43, wherein the received data is encoded, and wherein the decision circuit includes a demodulator, a decoder, and a re-encoder to form a re-coded-decoded decision.